SOFT WATER

PITTSBURGH FILTER MFG. CO.
Farmers' Bank Building,
PITTSBURGH, - - PA.

Gravity Filters Pressure Filters

Water Softening Plants

PURE WATER FOR ALL PURPOSES

PITTSBURGH FILTER MANUFACTURING CO.
Farmers' Bank Building Pittsburgh, Pa.

The Champlin Press
Columbus, Ohio.

Introduction

IN presenting this pamphlet to the public, we do so believing that all are thoroughly versed in the necessity of a modern system for the elimination of the deleterious properties found in water for manufacturing and domestic purposes. To those in search of such a system, this pamphlet is respectfully submitted.

WATER SOFTENING PLANTS—The methods employed by us for the softening of water for mechanical purposes are not new and untried. They date back to the discoveries made by Dr. Clark, of Aberdeen, Scotland, in 1841. Various types of appliances have been employed to carry out these discoveries in a practical way but nothing heretofore used has given the public such eminently satisfactory results as the apparatus installed by us, and the report of our clients confirms our statements.

Deleterious Properties Found in Water

All natural waters contain more or less foreign matter, either in suspension or solution, and the relative degree of purity is dependent on the locality in which they originate.

On account of its great solvent qualities nearly all water contains more or less scale-forming matter which it takes up from the earth through which it passes.

This quality of dissolving and holding in solution various solids is due to the carbonic acid gas which is contained in almost all water.

The amount of scale-forming matter in any water from a stream varies also from season to season and from day to day. In a wet season or after a rain, river water will be found to be comparatively pure; the scale-forming matter having been diluted with the pure rain water. In a dry season the water will become more highly charged with scale-forming matter as its volume decreases.

Water coming from coal mines or sulphur deposits will be found to contain amounts of sulphuric acid, sufficient to quickly corrode a boiler. Water highly charged with carbonic acid gas, as some natural waters are, will also corrode boilers.

Water containing calcium and magnesium chlorides cause corrosion in boilers by the hydrocholoric acid which is set free by heat.

Another common trouble with water of the Western United States is the alkaline compounds which are frequently found in them. These cause foaming in the boilers, especially when mud or vegetable matter is found in the water.

How the Impurities Are Divided

The impurities may, therefore, be divided into three classes :

First—Corrosive Impurities Consisting of	Second—Scale-Forming Impurities	Third—Alkaline Impurities
Sulphuric Acid ..... H_2SO_4	Calcium Carbonate..... $Ca(HCO_3)_2$	Sodium and Potassium Carb'e Na_2CO_3 & K_2CO_3
Carbonic Acid ..... H_2CO_3	Magnesium Carbonate..... $Mg(HCO_3)_2$	Sodium and Potassium Sulphate Na_2SO_4 & K_2SO_4
Sulphate of Iron..... $FeSO_4$	Calcium Sulphate ..... $CaSO_4$	Sodium and Potassium Chloride NaCl & KCl
Calcium Chloride..... $CaCl_2$	Iron Carbonate..... $Fe(HCO_3)_2$	
Magnesium Coloride..... $MgCl_2$	Magnesium Sulphate..... $MgSO_4$	

In its broadest sense, the purification of water refers to any process through which the quality may be improved and the water better adapted for the purpose of its intended use.

Water softening consists in the removal of the deleterious properties held in solution in the water and their retention outside the boilers.

These results may be accomplished by either an intermittent or continuous type of plant.

Description of the Largest Water Softening Plant in the World

—————————at the—————————

Tennessee Coal, Iron & Railway Co., Ensley, Alabama

The cut on the following page shows the largest water softening plant in the world. This apparatus purifies the water from Village Creek, a stream consisting of pollution only, for 35,000 horse power of boilers. The site selected for this plant was topographically perfect inasmuch as the purified water flows by gravity to the various industries in and around Ensley and Pratt City.

Precipitating Tanks

The entire apparatus is of steel construction. There are four precipitating tanks 30 ft. in diameter and 30 ft. high (exclusive of the sludge bottom.) They are mounted on pipe columns 8 feet above the foundation piers which allow ample room for removing the precipitated deposits. The stairs and platform are located between the tanks and afford access to all of them, but as the operation of the entire plant is accomplished from the ground it is not necessary to go up on top of the plant for its manipulation. Each tank is filled through a 16 inch line from the Company's pumping plant on Village Creek and is emptied through a floating outlet spout located in each tank, which draws the clear water from the top without disturbing the precipitate.

Treating Plant

The devices employed for introducing the reagents into the raw water consists of four solution tanks 5 feet in diameter and 5 feet high, equipped with slaking and agitating apparatus. There are two Weinman pumps which introduce the lime and soda solution into the raw water, proportional to the flow. The plant being in duplicate admits of one batch of solution being prepared while the other is being used.

Agitating Apparatus

The chemicals are mixed with the raw water by compressed air. This method is used exclusively by us and involves the most positive and uniform admixture. The air is furnished by a Rand Compressor which maintains a pressure of 20 to 25 pounds in the receiver.

Filters

There are two filters 20 feet inside diameter and 7 feet 6 inches high equipped with agitators. They have false bottoms to which the strainers are attached. The strainer system is the Company's usual bronze strainer and each filter contains 1256. On top of these strainers is placed 6 inches of gravel and 36 inches of Birmingham Filter Sand.

Stirring Engine

An Ajax Center Crank Engine operates the stirring devices in the filters which require washing once each week.

Clear Water Well

A clear water basin holding 18,000 gallons of water is built under the filters inside the building and contains filtered water for washing the filters.

Wash-Out Pump

A wash-out pump with a capacity of 2,000 gallons per minute is used for supplying wash water to the filters.

Gauges and Electric Annunciators warn the operator when the precipitating tanks are full of water and give him ample time to close the valves before the tanks overflow.

Pipe and Fittings

All the pipe and fittings used are cast-iron flanged with bolt and gaskets and all overhanging pipes are supported on steel trusses.

Operators

There are two operators at this plant, each having a 12 hour turn. These two men test the water and treat each tank as it requires. The very frequent changes in the quality of the water make these tests an absolute necessity.

Cost per Thousand Gallons

An official report places the average cost of the chemicals covering a period of six months at 2 cents per thousand gallons.

Results

In the annual report of President Bacon of the Tennessee Coal, Iron & Railway Company published in the Iron Trade Review we find the following:

"A water purifying plant has been placed in service at the Ensley Furnaces and has reduced the fuel consumption, increased the efficiency of the boilers, and decreased the repairs heretofore necessary."

LARGEST WATER SOFTENING PLANT IN THE WORLD. TENNESSEE COAL, IRON & RY CO., ENSLEY, ALA.

170,000 GALLONS OF WATER AGITATED WITH COMPRESSED AIR. T. C. I. & RY. CO , ENSLEY, ALA.

Analysis of Water from Village Creek

Tennessee Coal, Iron & Railway Co., Ensley, Ala.

Raw Water

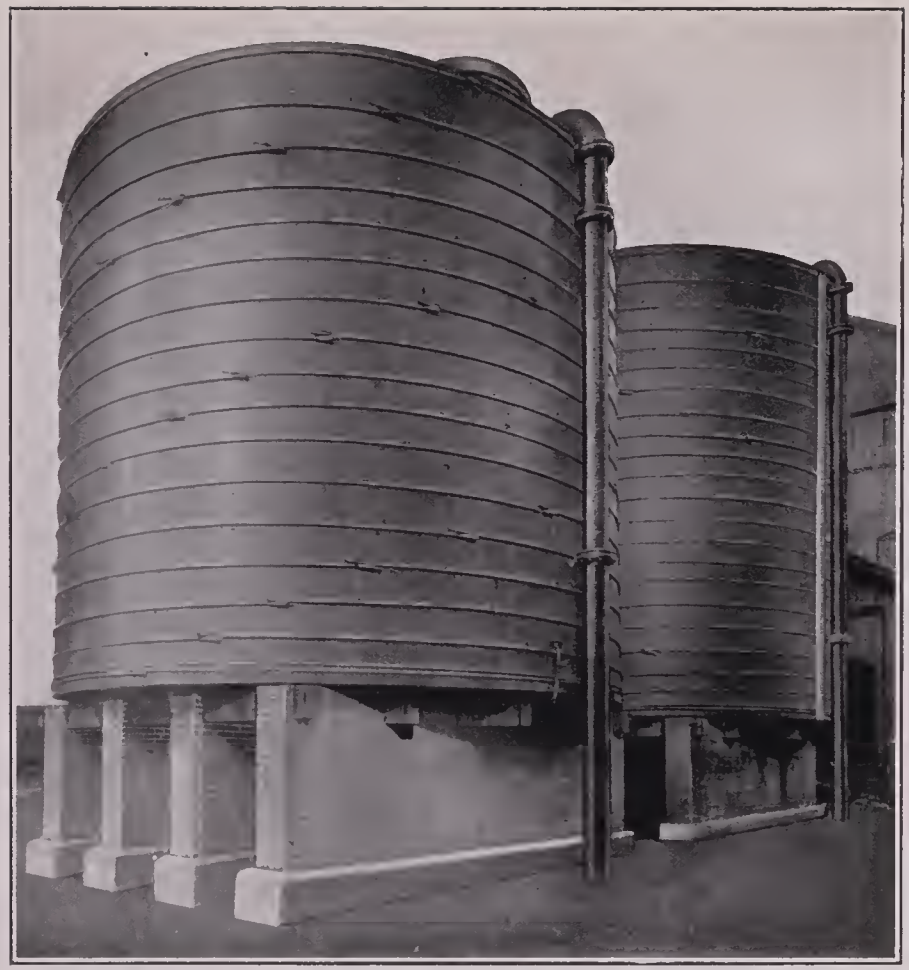
Grains per Gallon

Sodium Chloride	3.67
Calcium Sulphate	12.47
Magnesium Sulphate	11.00
Silica	4.02
Iron Sulphate	6.53
Organic Matter	1.92
Total Solids	39.61
Free Sulphuric Acid	8.91

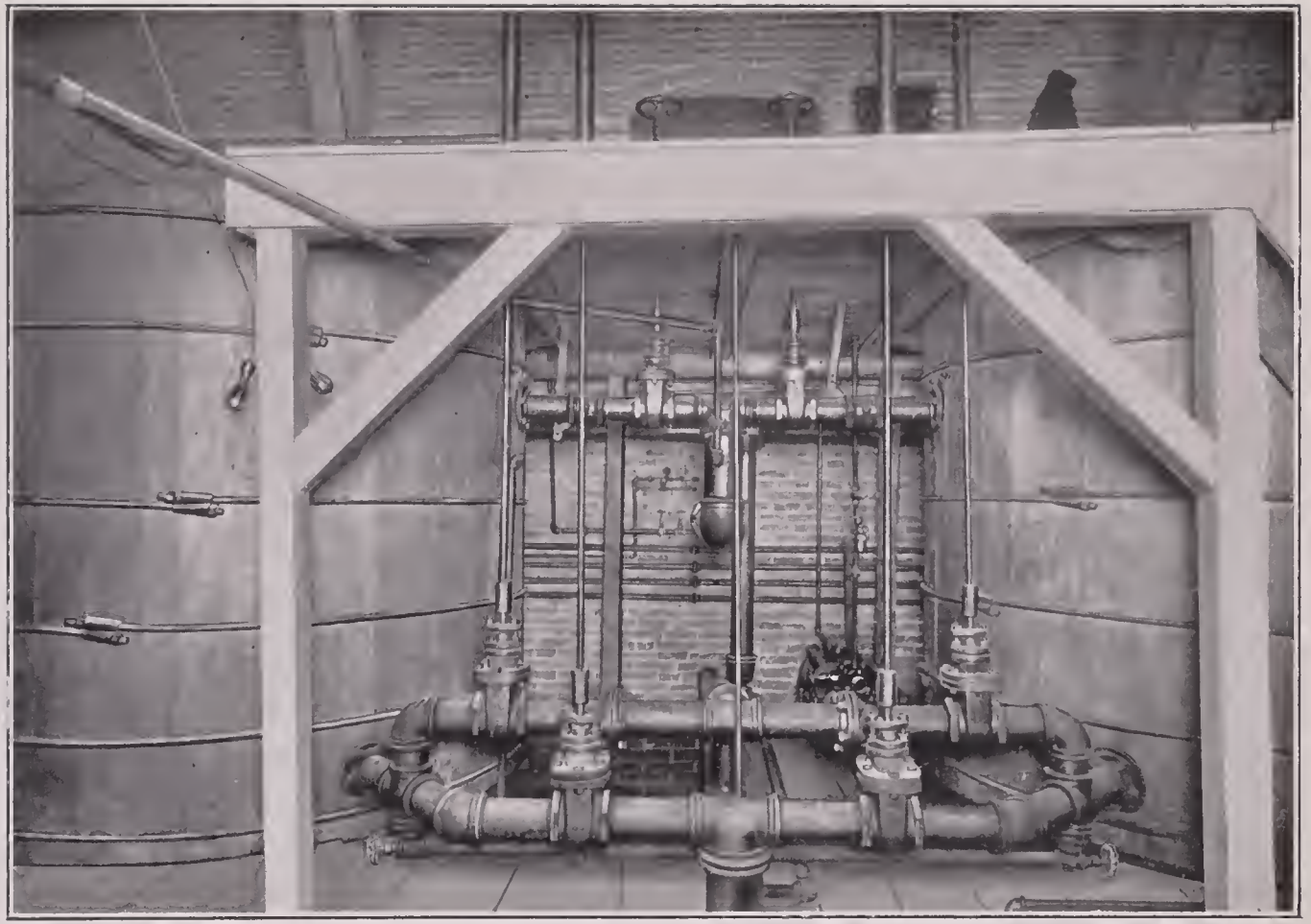
Purified Water

Grains per Gallon

Sodium Chloride	3.62
Calcium Sulphate	.81
Magnesium Sulphate	2.39
Total Solids	6.82



VIEW OF PRECIPITATING TANKS, CLEVELAND FURNACE CO., CLEVELAND, O.
300,000 GALLON INTERMITTENT WATER SOFTENING PLANT



VIEW OF FILTERS

CLEVELAND FURNACE CO., CLEVELAND, O.

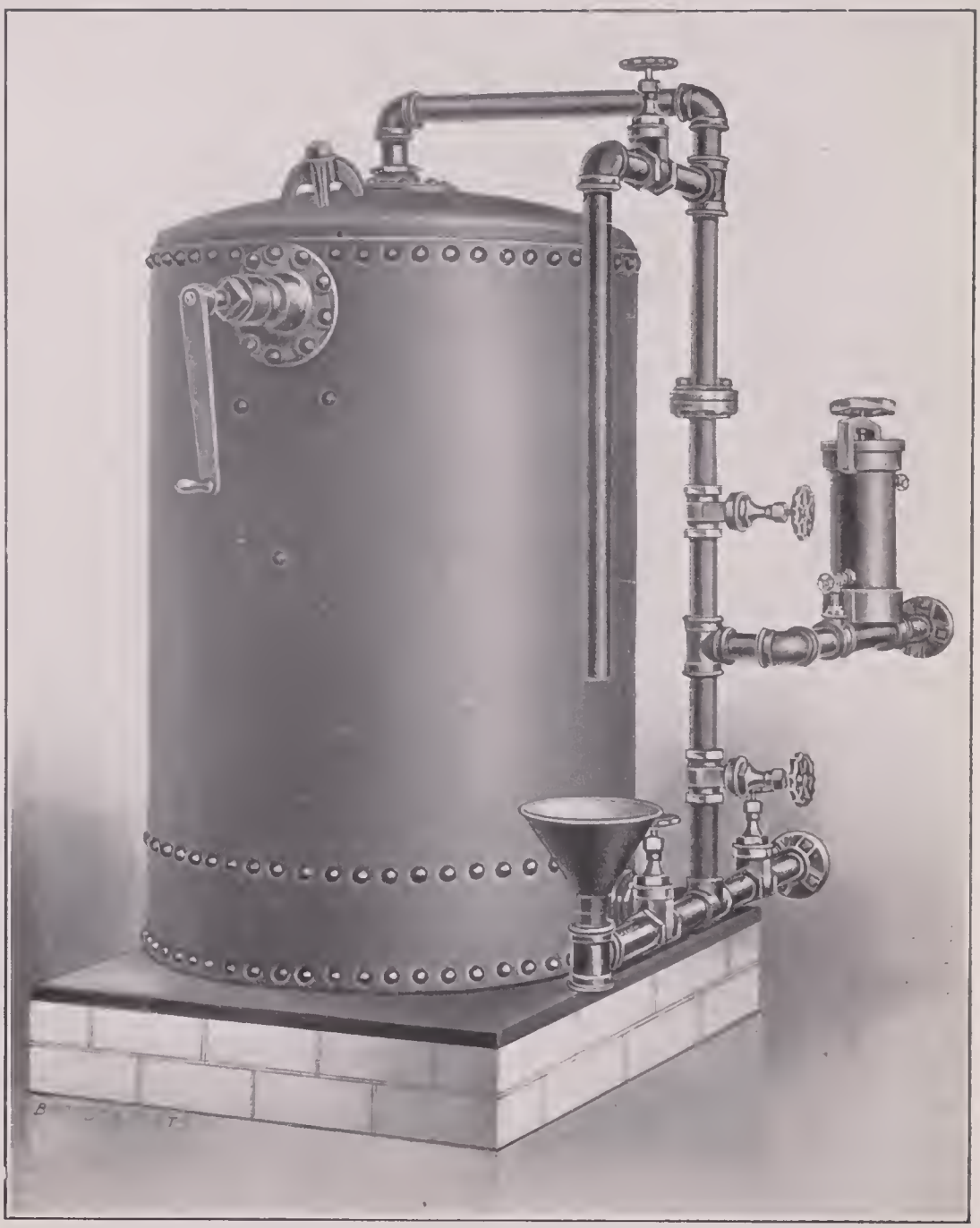
300,000 GALLON INTERMITTENT WATER SOFTENING PLANT

Incrustation in Steam Boilers

Scale is a deposit upon the boiler or boiler tubes of the foreign substances before referred to, and antagonizes the economy of steam through incrustation.

The destructive effect of scale forms the subject of such a wide amount of comment and warning that steam users might be presumed to be constantly on their guard to prevent it. As a matter of fact, except in instances where the effect is so pronounced as to imperatively demand the adoption of preventive means, the subject is too often neglected. Unfortunately, the evils arising from this cause are insidious and do not make themselves manifest until after substantial injury has occured, resulting in over-heating, crystallization or burning, and the ultimate destruction of the metal itself.

The proper use of a boiler is to evaporate water. It has neither room nor energy to spare for chemical operations.



32″x″48 Pressure Filter
Mutual Laundry Co., Pittsburgh, Pa.

Chemicals Used and Their Reactions

For almost all waters caustic lime and soda ash are the only chemicals which we use.

Caustic lime acts upon the carbonates of lime and magnesium which are in solution in the form of bi-carbonates. These substances react with the soluble bi-carbonate to form insoluble carbonate of lime and hydrate of magnesia. Mud or other solid matter will also be carried down with these precipitates; and carbonate of iron, if present, will be precipitated as hydrate of iron.

Soda ash reacts upon the sulphates of lime and magnesium and their allied compounds, decomposing them and forming insoluble carbonates, which are precipitated. Soda ash also neutralizes any acids present in the water, destroying their corrosive power. Chlorides and nitrates of lime and magnesium act like the sulphates. The reactions which take place between the chemicals and the substances in solution in the water are as follows:

Lime Process

Calcium Bi-Carbonate $Ca(HCO_3)_2$ + Lime Solution $Ca(OH)_2$ = Calcium Carbonate $CaCO_3$ + Water $2H_2O$
Magnesium Bi-Carbonate $Mg(HCO_3)_2$ + Lime Solution $2Ca(OH)_2$ = Magnesium Hydrate $Mg(OH)_2$ + Calcium Carbonate $2CaCO_3$ + Water $2H_2O$
Carbonic Acid H_2CO_3 + Lime Solution $Ca(OH)_2$ = Calcium Carbonate $CaCO_3$ + Water $2H_2O$
Sulphuric Acid in water H_2SO_4 + Lime Solution $Ca(OH)_2$ = Calcium Sulphate $CaSO_4$ + Water $2H_2O$
Bi-Carbonate of Iron $Fe(HCO_3)_2$ + Lime Solution $2Ca(OH)_2$ = Calcium Carbonate $2CaCO_3$ + Iron Hydrate $Fe(OH)_2$ + Water $2H_2O$

Chemicals Used and Their Reactions

Soda Ash

Lime Sulphate $CaSO_4$	Soda Ash Na_2CO_3		=Calcium Carbonate $CaCO_3$	Sodium Sulphate Na_2SO_4	
Magnesium Sulphate $MgSO_4$ +	Soda Ash Na_2CO_3 +	Lime $Ca(OH)_2$	=Magnesium Hydrate $Mg(OH)_2$ +	Sodium Sulphate Na_2SO_4 +	Cal.Carb. $CaCO_3$
Chloride of Lime $CaCl_2$	Soda Ash Na_2CO_3		=Calcium Carbonate $CaCO_3$ +	Sodium Chloride 2NaCl	
Chloride of Magnesium $MgCl_2$ +	Soda Ash Na_2CO_3 +	Lime $Ca(OH)_2$	=Magnesium Hydrate $Mg(OH)_2$ +	Sodium Chloride 2NaCl	Cal.Carb. $CaCO_3$
Nitrate of Lime $Ca(NO_3)_2$ +	Soda Ash Na_2CO_3		=Calcium Carbonate $CaCO_3$ +	Sodium Nitrate 2$NaNO_3$	

The art of water softening and purification, in competent hands, has reached almost the final stage of perfection and cheapness. Fresh lime and sodium carbonate are the most efficient chemicals for the purpose, and are also the cheapest.

The Colorado Fuel & Iron Company

Have installed at their Minnequa Works a Continuous Water Softening Plant capable of supplying water for 10,000 Horse Power of boilers.

The water supply is taken from the "Bessemer Ditch" and contains the following impurities:

Raw Water

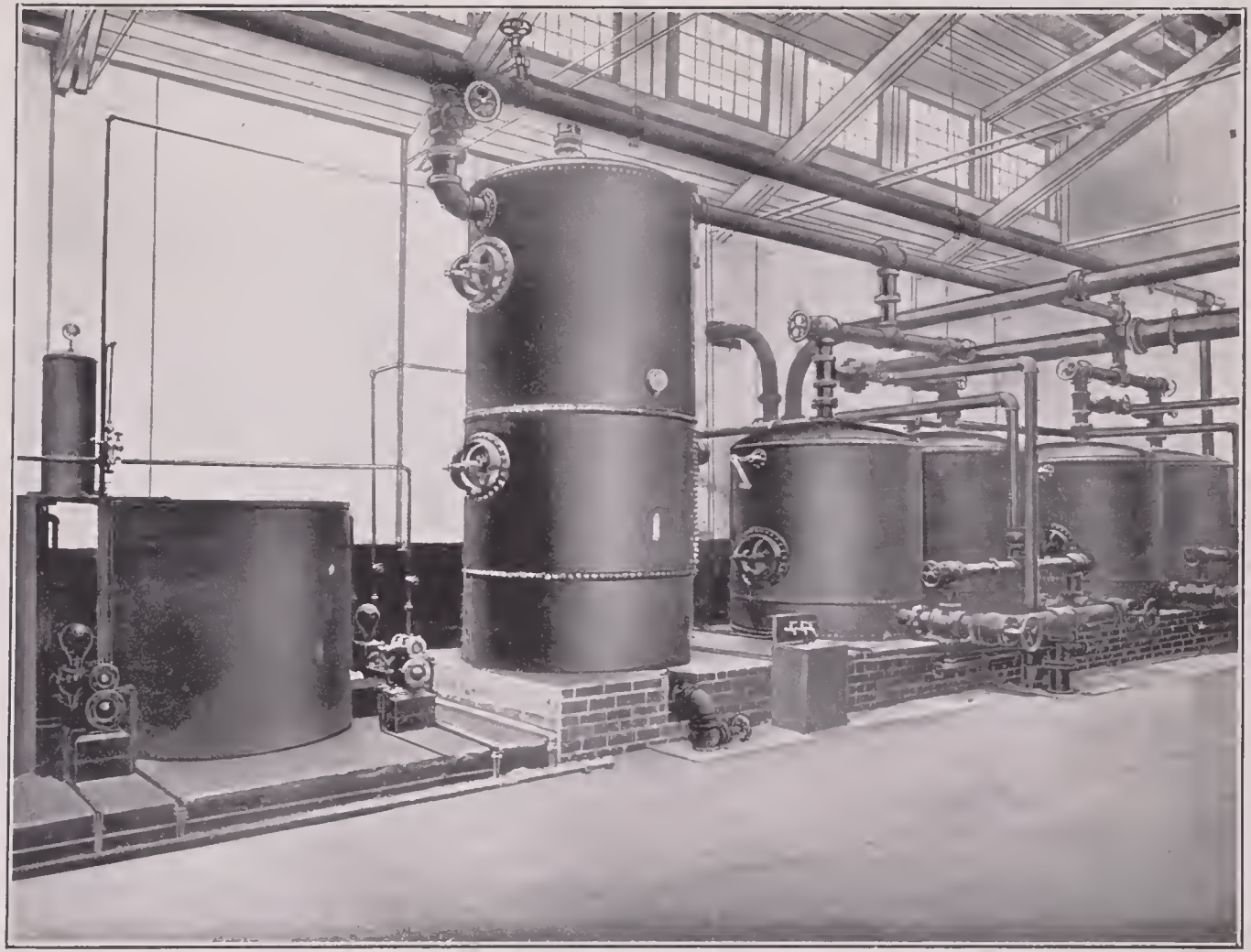
Grains per Gallon

Sodium Chloride	1.39
Calcium Sulphate	27.76
Magnesium Sulphate	1.88
Magnesium Carbonate	5.49
Total Solids	36.52

Purified Water

Grains per Gallon

Sodium Chloride	1.26
Calcium Sulphate	1.01
Magnesium Sulphate	2.18
Total Solids	4.45



COLORADO FUEL AND IRON CO. WIRE MILL DEPARTMENT, PUEBLO, COLORADO.

1,000,000 GALLON WATER SOFTENING PLANT

How to Get Soft Water

Analyze the water and find out what harmful impurities it contains. Then remove the impurities before the water goes into the boiler.

To do this successfully requires a properly constructed apparatus—one that will treat the water properly and will supplement the work of the reagents.

Chemical analysis shows what reagents to use, while the practical experience gained by years of study and research, coupled with the marked success of the apparatus in actual use, demonstrates conclusively that we have solved the problem of constructing a machine that mixes these reagents in exactly the right proportion to insure the precipitation of the harmful matter and then remove it.

The idea is simple—the method is simple—the results are correct.

Expense of Operation

The cost of operation varies somewhat, but the general run of waters can be treated at an expense of from one to two cents per 1,000 gallons, including cost of chemical reagents and labor.

The item of labor is insignificant, requiring but a few minutes attention each day from the Station Pumper or Engineer who can easily see to the charging of the apparatus and the blowing off of the sludge, in connection with his other duties.

The two cheapest reagents known—common lime and soda ash—are used; both are easily obtainable at any time in the open market—the price of soda is about $1.00 per hundred weight; the price of lime is usually fifty (50) cents per barrel of 210 pounds.

Laboratory

We have use of the most complete laboratory in the world where all our own chemical, microscopic, and bacteriological tests of water are made. It is our custom to make complete analyses and practical tests of all water, to determine the best and most economical methods of purification. Parties wishing complete reports on the purification of their water supply should write for instruction as to taking the sample and preparing it for shipment.

Plants of Special Design

The various types of apparatus manufactured by us can be adapted to suit all conditions as to location and purpose. We have both the Gravity and Pressure Type of Filters—the Continuous and Intermittent Type of Softeners—which will purify either hot or cold water and remove the objectional properties therefrom in any case.

Our statements are based on the actual work which has been done. We are not an experiment. All we ask for is an opportunity to demonstrate what we can do.

We guarantee results—We ask for no pay until we have proven our statements

Our proposition is a fair one.

Strainers

The Ideal Strainer is placed in all our filters, whether of the Gravity or Pressure Type. Engineers and practical men invariably agree that a more efficient strainer could not be devised. When the reverse current is applied in the cleansing process, jets of water are thrown in every direction, the entire filter bed is broken up, and all fine particles of precipitated matter are readily washed out.

In the Ideal Strainer, if a grain of sand or quartz comes in contact with the opening in the strainer, it touches on two points only. It cannot enter the slot or fill it up. In reversing the water, the jet strikes a solid head and does not cut through. These strainers are placed on 6 inch centers and in washing a more perfect distribution of water has never been attained.

The Ideal Strainer Used in the Pittsburgh Filter

Soft Water for Sugar Refineries

At the works of the National Sugar Manufacturing Company, Sugar City, Colorado, a water softening plant of 2,500 horse power was installed in August, 1900. This plant has been in operation each season ever since, making long continuous runs extending over a period of five months at a time. The boilers are of the water tube type and during these long periods of service not a tube has been lost. These results are phenomenal when the character of the water is taken into consideration.

THE NATIONAL SUGAR MANUFACTURING COMPANY'S WORKS, SUGAR CITY, COLORADO

250,000 GALLON WATER SOFTENING PLANT

ECLIPSE LAUNDRY COMPANY,

PITTSBURGH, PA., January 19th, 1904

PITTSBURGH FILTER MFG CO.,
Farmers Bank Bldg.,
C i t y.

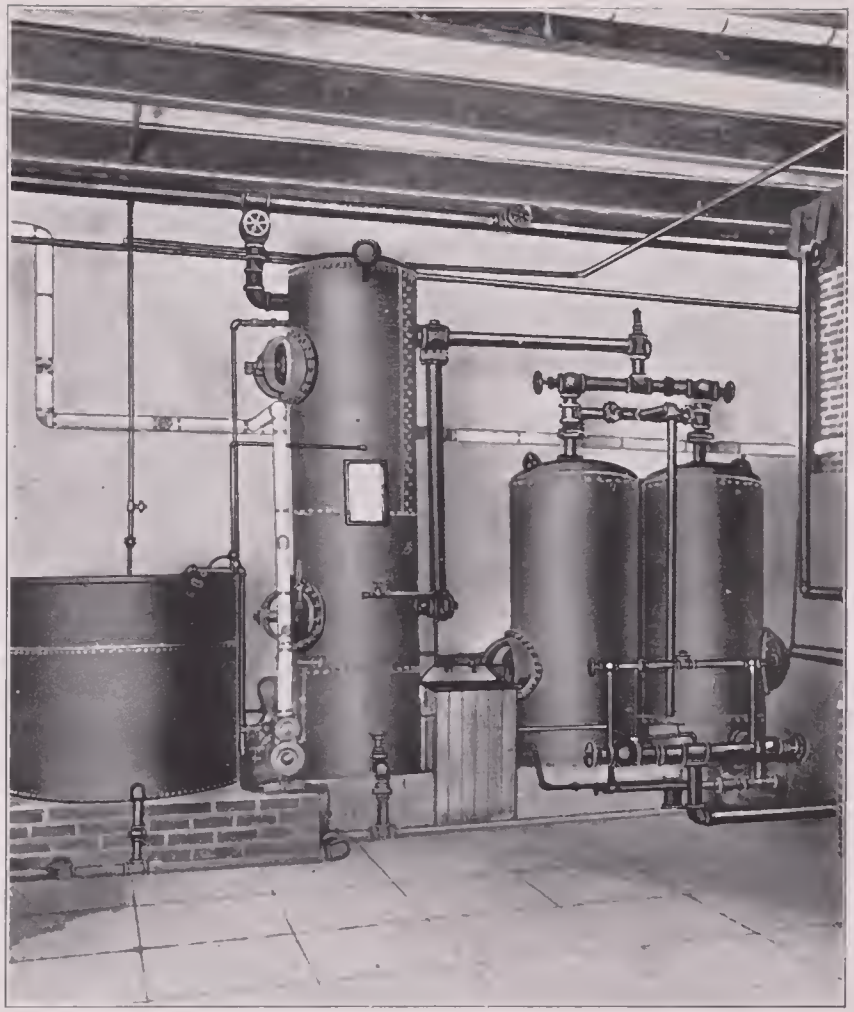
Gentlemen:-

We have installed in our Laundry the Pittsburgh Filter and have used it for the past three years. It has proved to be very successful, and were we in the market for another filter plant, would certainly put in the same type of plant again, as we find it durable and efficient in every particular.

Yours truly,

ECLIPSE LAUNDRY COMPANY.

Jas. A. Reed President



ECLIPSE LAUNDRY COMPANY, PITTSBURG, PA.

50,000 GALLON FILTER PLANT

Industrial Plants

In addition to the saving effected by the use of soft water in boilers, it is an important item of economy in many industries. Laundries, for example can effect a material saving by using soft water. Each grain of lime in one gallon of water produces what is called one degree of hardness. Each degree of hardness destroys 1.7 pounds of the best hard soap before a lather is produced in 1000 gallons of water and leaves an insoluble curd which becomes entangled in the fabrics washed, and cannot be removed by rinsing. The heat of the iron decomposes these curds, and leaves brownish soap spots on the goods.

The following table shows the comparative amounts of soap required to produce a permanent lather in waters of different degrees of hardness, and the saving effected by the use of soft water:

DEGREES OF HARDNESS	POUNDS SOAP DESTROYED PER 1,000 GALLONS	COST OF SOAP AT 5 CENTS PER POUND
5	8.5	$0.41
10	17.0	0.82
15	25.5	1.23
20	34.0	1.64
25	42.5	2.05

Goods washed in softened water are cleansed with a minimum amount of soap, are much finer and whiter in appearance, and softer in texture, while no dark color appears.

Analysis of Water Used
The Morey-LaRue Steam Laundry, Elizabeth, N. J.

BEFORE PURIFICATION		AFTER PURIFICATION	
Sodium Chloride	5.46 grains per U. S. gal.	Lime	1.69
Sodium Sulphate	2.67	Magnesia	2.60
Calcium Sulphate	19.72		
Magnesium Sulphate	4.49	Total Hardness	4.29
Magnesium Carbonate	.34		
Aluminum Oxide	.23		
Silica	1.51		
Organic and Volatile Matter	.13		
Total Solids	34.55		

100,000 GALLON INTERMITTENT WATER SOFTENING PLANT MOREY LA RUE LAUNDRY, ELIZABETH, N J

Form 124

PRESSED STEEL CAR COMPANY,

OFFICE OF SUPERINTENDENT,

McKEES ROCKS WORKS.

McKees Rocks, Pa. Nov. 15th., 1901.

Mr. J. B. Greer,

Pittsburgh Filter Mfg. Co.,

Pittsburgh, Pa.

Dear Sir:-

Your favor 11th. received, and in reply beg to advise that the filters put in at the McKees Rocks works have been giving entire satisfaction up to the present time.

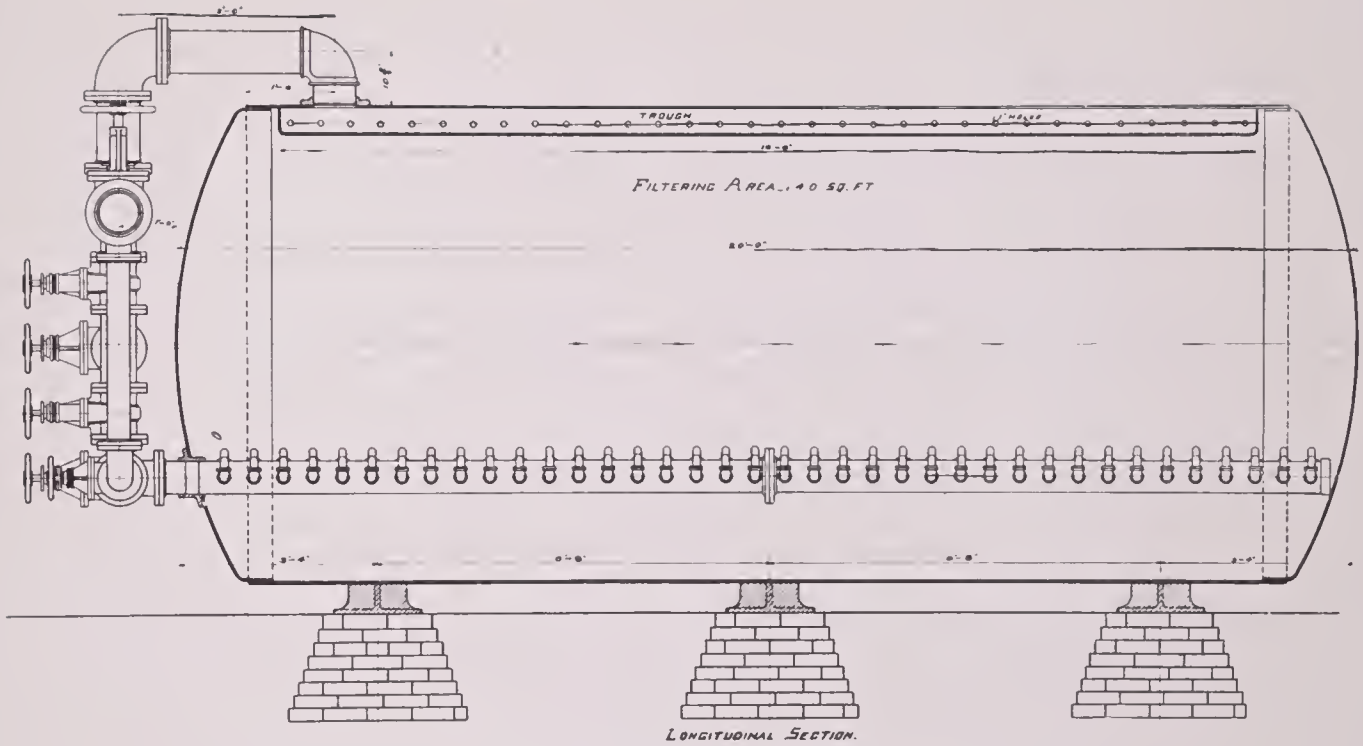
Yours truly,

Pressed Steel Car Company,

R. M. Wood

Superintendent.

car-t



8′x20′ Horizontal Pressure Filter. 500,000 Gallon Daily Capacity
Champion Coated Paper Co., Hamilton, Ohio.

Industrial Plants

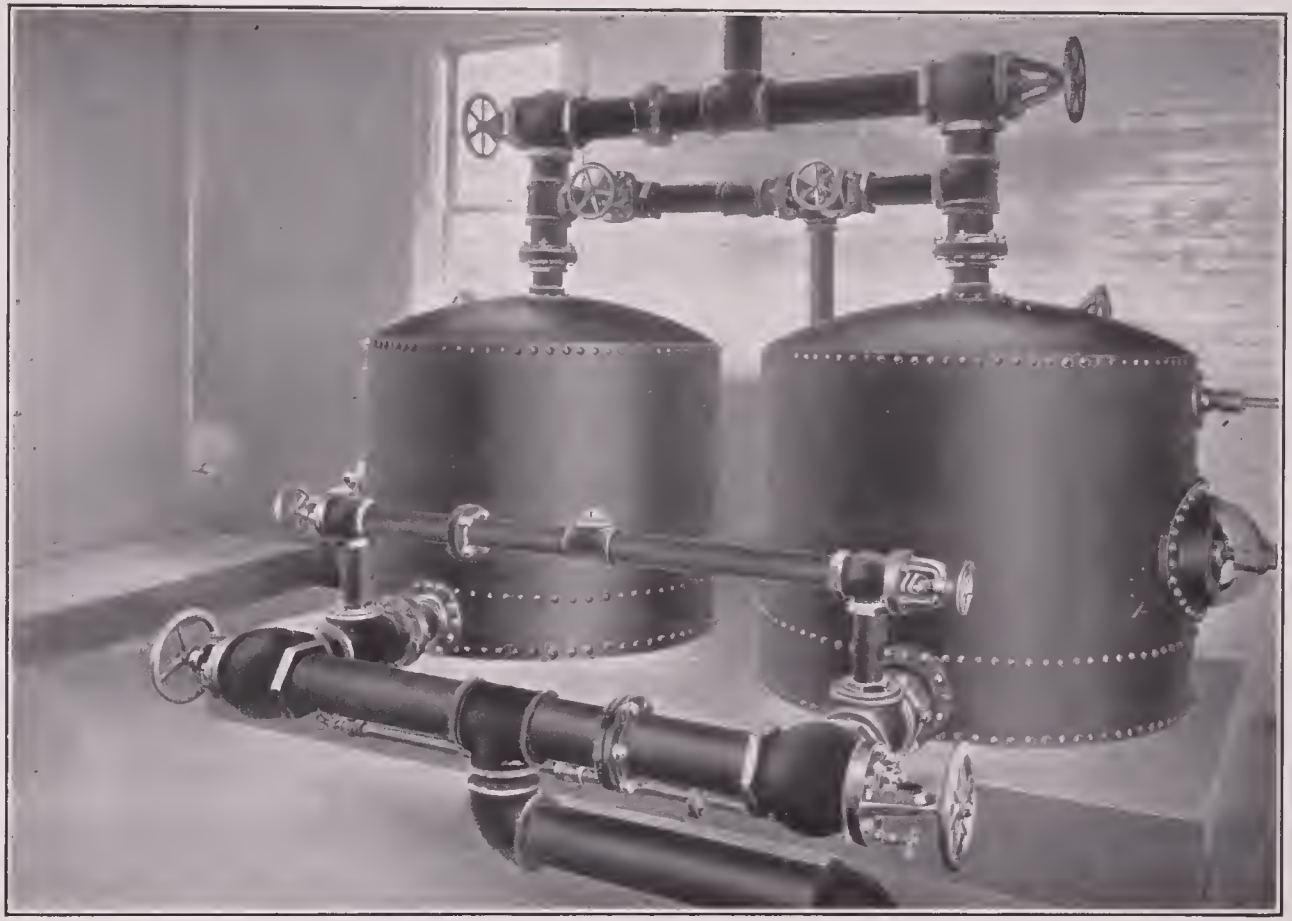
Paper Mills require a soft water to secure the best results (for paper pulp forms a filter that absorbs any impurities in the water, and these impurities reduce the quality and increase the cost of manufacture.) The Pittsburgh System furnishes this.

For ice plants the advantages of purified water are manifest—keeping condensers and boilers free from scale and removing the carbonic acid gas which is largely responsible for the core in can ice.

For distilleries, refineries, etc., soft water is most desirable. Fermentation takes place quicker with soft water than with hard, and retorts, condensers, etc., attain their highest efficiency only when soft water is used.

For tanneries soft water is essential, as salts of calcium and magnesium, unless removed by the softening process, precipitate the tannin from the tannin extract, thereby rendering a portion of the extract useless, and greatly increasing the cost of tanning the hide. Soft water also produces a more uniform and softer leather than hard water.

An Ideal City Supply can be secured by the Pittsburgh System. The impurities either in solution or suspension are entirely eliminated and a pure soft, clear water is the result, clear for the household—soft for the laundry, and pure for the public's good.



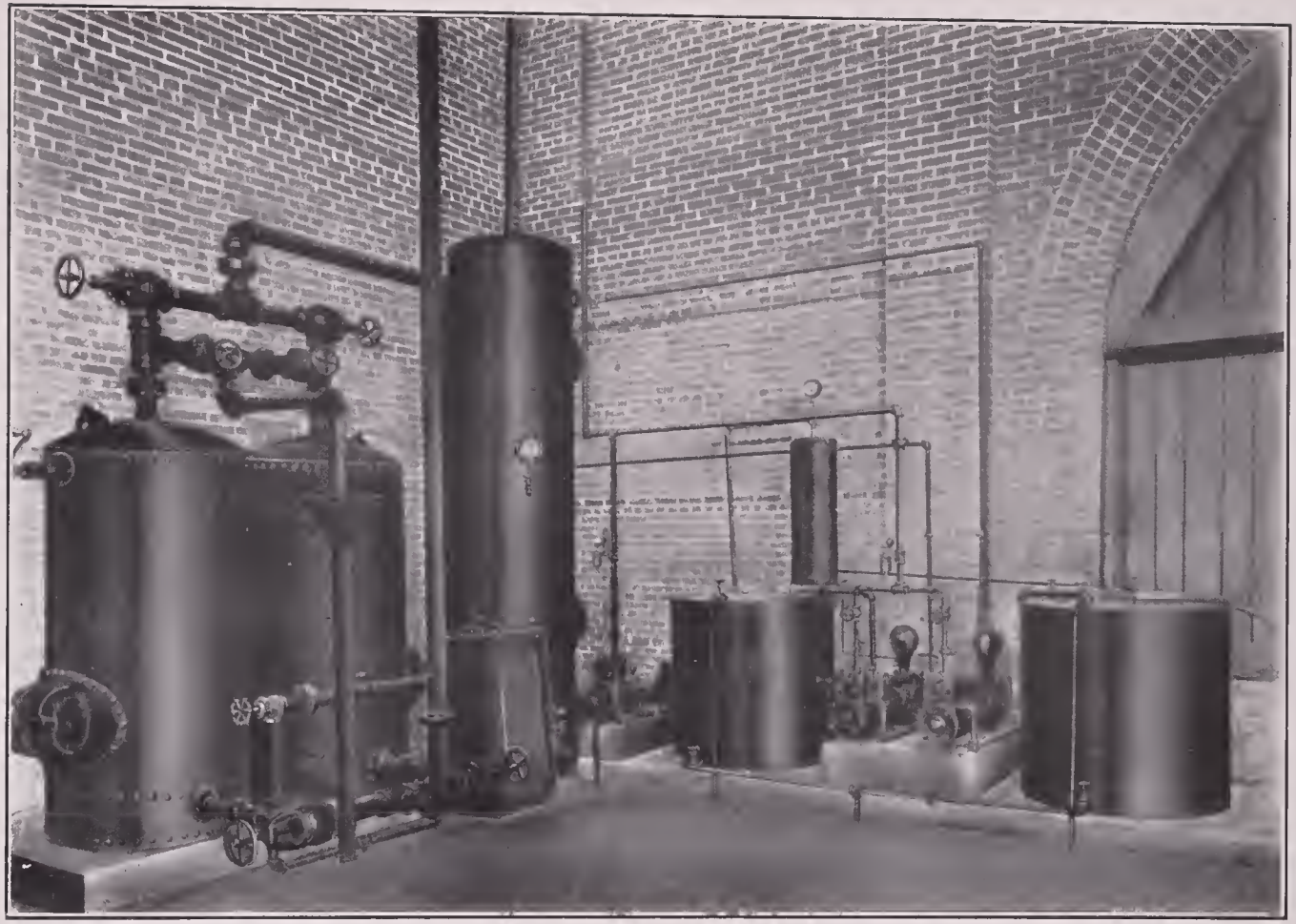
200,000 Gallon Pressure Filter Plant Built for
Pressed Steel Car Co., McKees Rocks., Pa.

Guaranteed Results

Every plant installed by us is guaranteed to produce definite results before it is built. You know exactly what the machine will do, and what it will cost to do it, before you give your order.

You do not pay for the apparatus until it is installed, is in perfect working condition, and you know from actual, practical test, that it is doing all we claimed it would do, and that the cost of operation is within the limit of our guarantee.

Unless the apparatus fulfills all our guarantees,—it's ours.



WICKWIRE BROTHERS, CORTLAND, N. Y.

1,000 H.P. WATER SOFTENING PLANT

Corrosion

Corrosion is one of the most destructive agents to which boilers are subjected. It arises from the presence of acids in the water, which gradually concentrate as evaporation goes on, and combine with the material of which the boiler is constructed, causing "pitting" and honeycombing of the most susceptible parts. Under the head of corroding solids there are three very dangerous acids which frequently contaminate water found more or less throughout this country. Of these three the most dangerous is sulphuric. This destructive element owes its presence to drainage from coal or ore mines, paper mills, galvanizing works and oil refineries, and may be noted by the dark green tinge of the water. In an inconceivably short space of time its presence is noticeable in the boiler by the red discoloration of the water. This is brought about by the action of the sulphuric acid upon the iron of which the boiler is constructed, producing iron sulphate; which is separated from the water as ebullition goes on, and as it is non-volatile a new supply of iron is constantly taken up by the acid until the plates in time will be actually destroyed. The same conditions exist where hydrochloric, nitric, tannic, acetic or carbonic acids are present, except that in these instances the action is of a milder form, but water impregnated with either of these acids should never be used for steam purposes except having first been purified. Iron sulphate in its natural state, and alumina sulphate, are also corrosive agents, and should receive proper consideration while reviewing this class. While not so destructive when the water is at its normal temperature, when heated a separation takes place, leaving a concentrated free acid which acts injuriously upon the plates and tubes of a boiler. When scale is permitted to form in a boiler fed with an acid water, the danger is increased, and the further weakening of the structure thus caused is naturally concealed.

Priming

Water which contains alka i or organic matter, permits the formation of a scum on the surface of the heated water,and prevents the steam from rising until the accumulated pressure is sufficient. This results in great quantities of heated water, being thrown up and mixed with the steam, or it may be due to not blowing off the boilers frequently.

Alkali waters are the sources of supply for many localities, especially in the Western States, and cause much trouble to users of steam. A great portion of the efficiency of locomotives is lost through the use of these waters.

Natural waters containing large quantities of sodium or potassium, either in the form of chlorides or carbonates, are difficult to treat. In fact, neither sodium nor potassium salts can be removed from a water except by distillation, but a water containing these salts may be greatly improved, and, rendered fit for boiler use, by the removal of the other salts which the water contains.

Description of the Pittsburgh Filter Manufacturing Company's Intermittent Water Softening Plant

A sample of raw water is tested to determine the amount of chemicals required per thousand gallons and by referring to the table of standards furnished by us, the amount of material for each tank of water is found. The chemicals are weighed out carefully for each tank and dissolved in the lime and soda tanks.

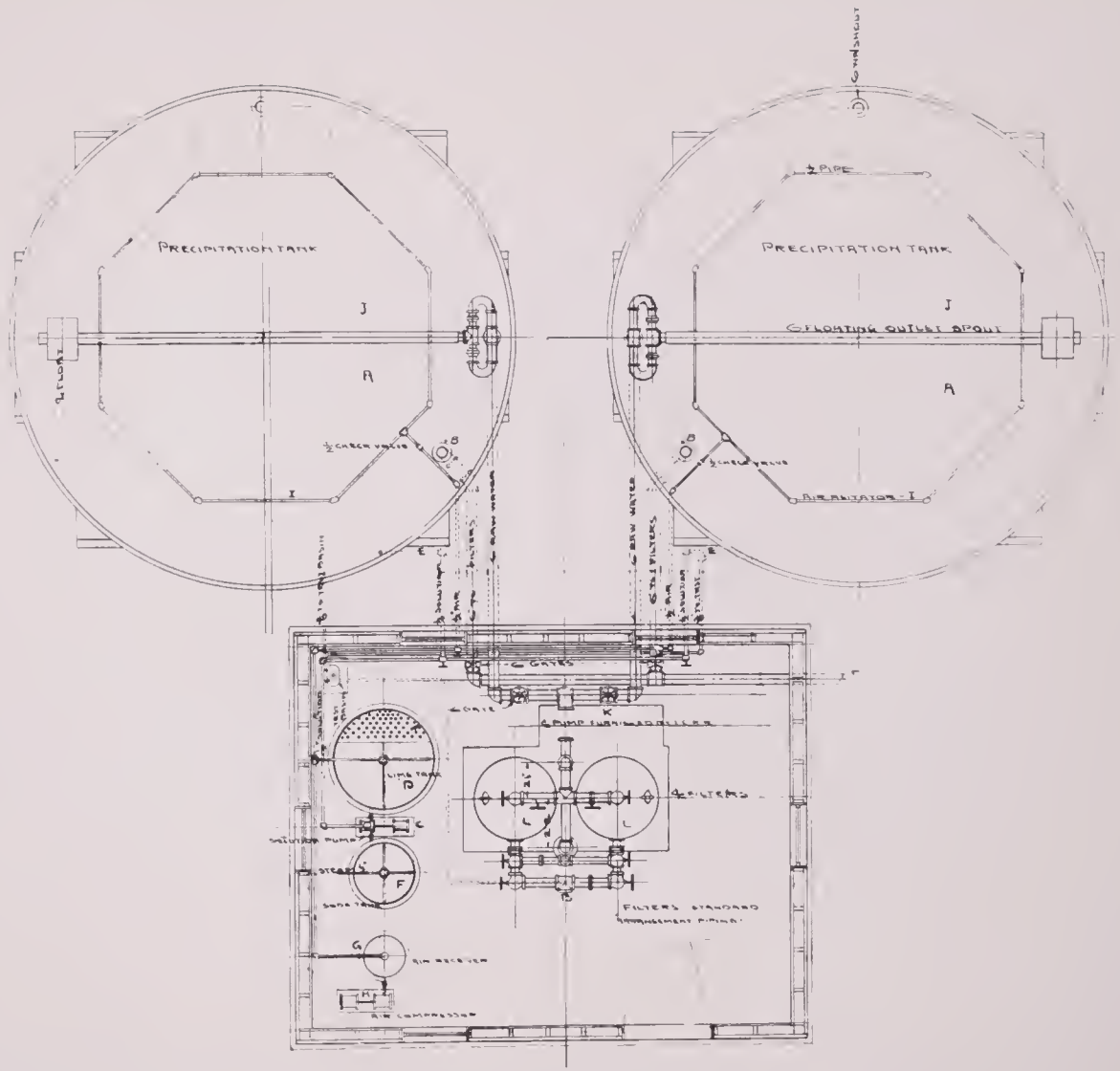
The raw water to be purified passes into either of the settling tanks "AA" through inlet pipe "BB." While a tank is being filled with water the solution pump "C" delivers lime solution from the solution tank "D" through line "E" into this tank of water. When the water is within two feet of the top, the soda ash is introduced in the same manner from solution tank "F." When the chemicals have been added, the water is thoroughly agitated with air from the air receiver "G" where a pressure of ten to fifteen pounds of air is maintained with the compressor "H."

Uniform agitation of the water in the tank is accomplished through the agitator rings "I" for fifteen (15) minutes or longer and the water is allowed to settle for one hour or more, depending on the quality of same. It then passes out through the floating outlet spout "J" through the filters "L-L" into the clear water well or other point of delivery.

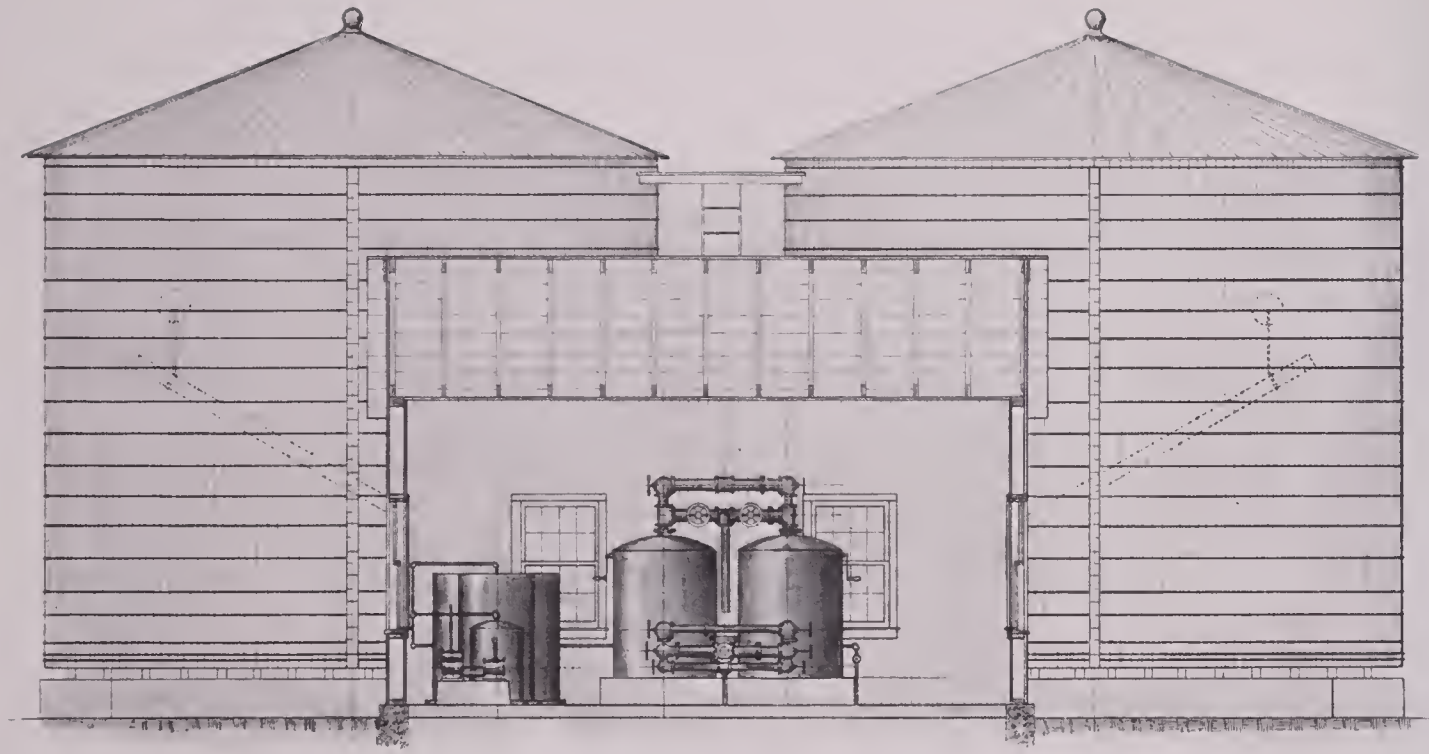
When one tank is being emptied of the purified water the other one is being prepared for use. Each tank of water is tested after it has been treated and the amount of impurities determined. If it is not right, a sufficient amount of material is added to make the correction and no water is allowed to enter your boilers, road-side tubs or other point of delivery until it has been found to be absolutely right and a uniform supply is always maintained by this system no matter if the water changes every day.

This plant is operated from the ground and it is not necessary to go up on the tanks at any time during the process of treatment.

The building which houses the filter plant and treating apparatus is of sufficient size to carry thirty (30) day's supply of chemicals for treatment.

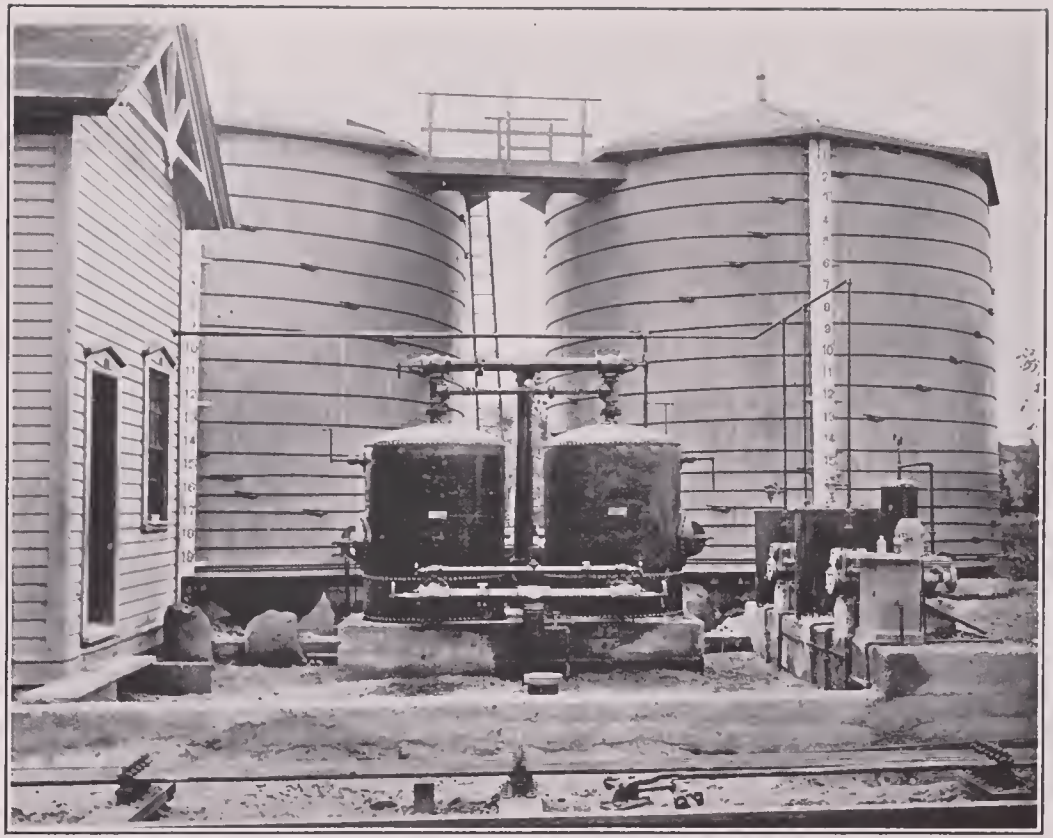


General Plan Intermittent Water Softening Plant



LEHIGH VALLEY RAILROAD COMPANY, STAFFORD, N Y

350,000 GALLON WATER SOFTENING PLANT



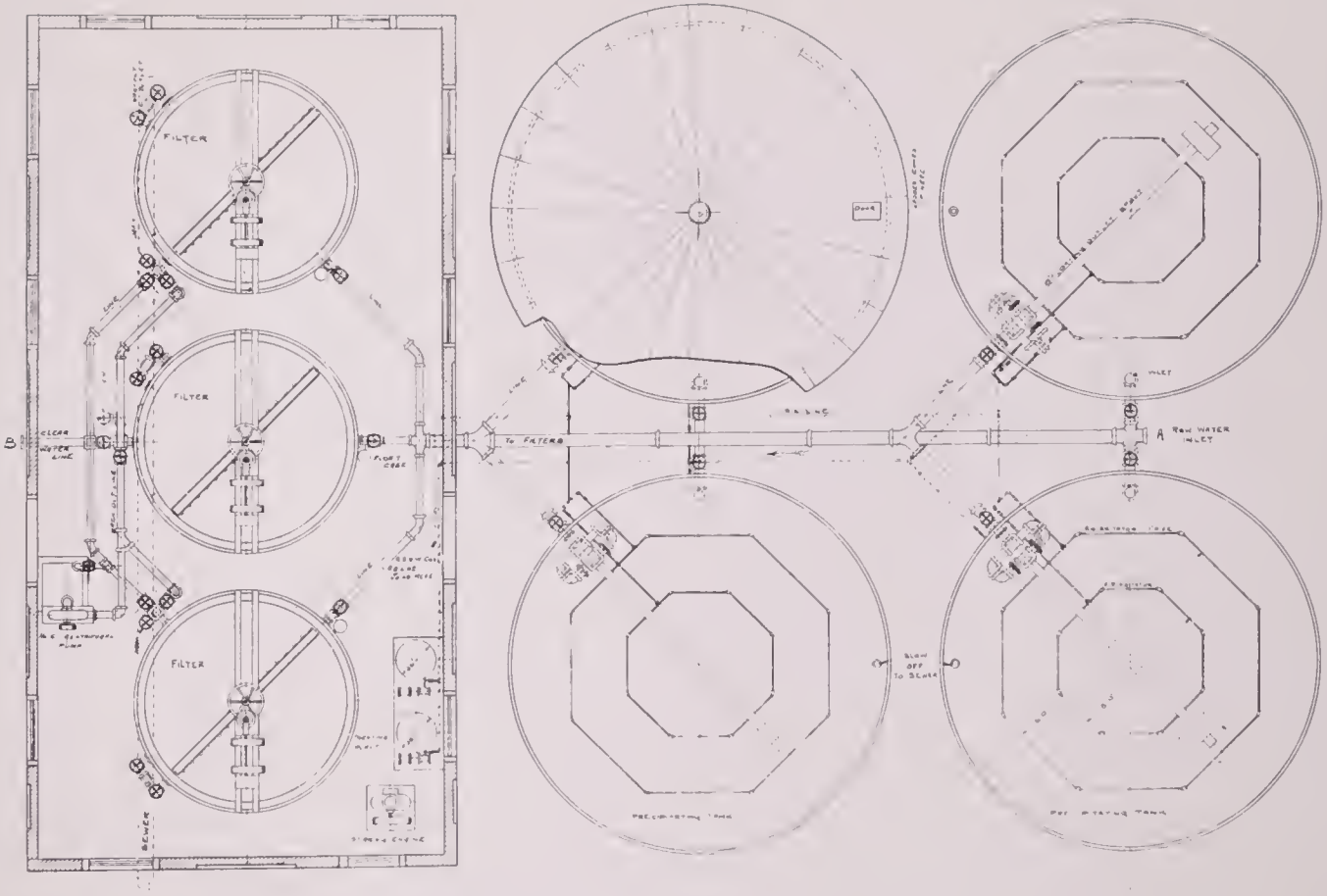
Intermittent Water Softening Plant
Lehigh Valley R. R. Co., Rochester Junction, N. Y.

The Central Furnace Plant

The second largest water softening plant in the world supplying water for industrial purposes is in operation at the Central Furnaces of the American Steel & Wire Company at Cleveland, Ohio.

The water used at this plant is taken from the Cuyahoga River and is highly charged with scale producing material and much suspended matter. The result guaranteed, viz., the removal of 95 per cent of the hardening properties and all suspended matter has been realized and a bright, soft water is always supplied.

There are four precipitating tanks 26 feet in diameter and 22 feet high, covered with concrete roofs, and three 15 foot Pittsburgh Gravity Filters. The wash-out pump and line shaft for driving the agitators in the filters are driven by a 50 H.P. Engine, and agitation for the precipitation tanks is produced by air supplied by the Furnace Company.



AMERICAN STEEL AND WIRE COMPANY, CLEVELAND, OHIO

20,000 H. P. WATER SOFTENING PLANT

Castalia Portland Cement Company, Castalia, Ohio

ANALYSIS OF WATER

RAW WATER

Grains per Gallon

Sodium Chloride	1.39
Calcium Sulphate	39.61
Calcium Carbonate	6.72
Magnesium Carbonate	6.77
Silica	14
Total Solids	54.63

PURIFIED WATER

Grains per Gallon

Sodium Chloride	1.21
Calcium Sulphate	2 23
Magnesium Carbonate	.21
Total Solids	3.6

Cincinnati Northern Railroad Company, Van Wert, Ohio

Analysis of Water Before and After Purification

RAW WATER

Grains per Gallon

Carbonate of Lime	7.83
Carbonate of Magnesium	1.57
Sulphate of Lime	28.83
Sulphate of Magnesium	23.80
Sulphate of Soda	5.76
Chloride of Soda	2.58
Silica	.70
Total Solids	71.07

PURIFIED WATER

Grains per Gallon

Carbonate of Lime	.27
Sulphate of Lime	2.18
Sulphate of Magnesia	1.60
Total Hardness	4.05

CINCINNATI NORTHERN RAILROAD COMPANY, VAN WERT, OHIO

60,000 GALLON WATER SOFTENING PLANT

The Van Wert Water Supply

The water used by the Cincinnati Northern Railroad at Van Wert, Ohio, is possibly the worst water used for locomotives east of the Mississippi River. The supply comes from wells, and, being located in an oil producing district, is found to contain considerable sulphate and chloride of soda. Being a terminal point a great deal of water is used by both road and switch engines. Each 1,000 gallons of the raw water contains 10.45 lbs., of scale producing matter and fire-boxes have been found to last a very short period of time.

CINCINNATI NORTHERN RAILROAD COMPANY, VAN WERT, OHIO

THE FILTERS AND TREATING PLANT

Intermittent Water Softening Plant at Punxsutawney, Pa.

Buffalo, Rochester & Pittsburgh Railway Company

The water supply of the Buffalo, Rochester & Pittsburgh Railway Company at Punxsutawney is taken from Mahoning Creek which is supplied chiefly from mine drainage. The corrosive properties in the water has in former years produced disastrous results in the locomotive boilers. An analysis of the water before and after purification is as follows:

RAW WATER

Grains per Gallon

Sodium Chloride	.60
Magnesium Sulphate	.81
Iron	.82
Silica	.46
Total Solids	2.69
Free Sulphuric Acid	3.69

PURIFIED WATER

Grains per Gallon

Magnesium Sulphate	.10

Free Sulphuric Acid and Iron Sulphate entirely eliminated.

BUFFALO, ROCHESTER AND PITTSBURGH RAILWAY CO., PUNXSUTAWNEY, PA

300,000 GALLON WATER SOFTENING PLANT

Personal Investigation

Waters vary—and likewise conditions. Therefore, before making a proposition for the installation of a water softening apparatus or filtration plant we prefer to have a sample of such water for our own analysis, as we make certain determinations which do not usually enter into the ordinary water analysis.

Such samples should always be forwarded in glass stoppered bottles, with the corks tied down tight and sealed.

This enables us to make the most economical tests for the construction of the device and to insure its highest efficiency.

Each installation is made under our direct, personal supervision, and only after a thorough investigation has proved conclusively that results satisfactory to you and to us can be obtained.

INTERMITTENT WATER SOFTENING PLANTS ON D. L. & W. RY., GROVELAND AND EAST BETHANY, N. Y.

A Model Water Softening Plant
Delaware, Lackawanna & Western R. R., Bath, N. Y.

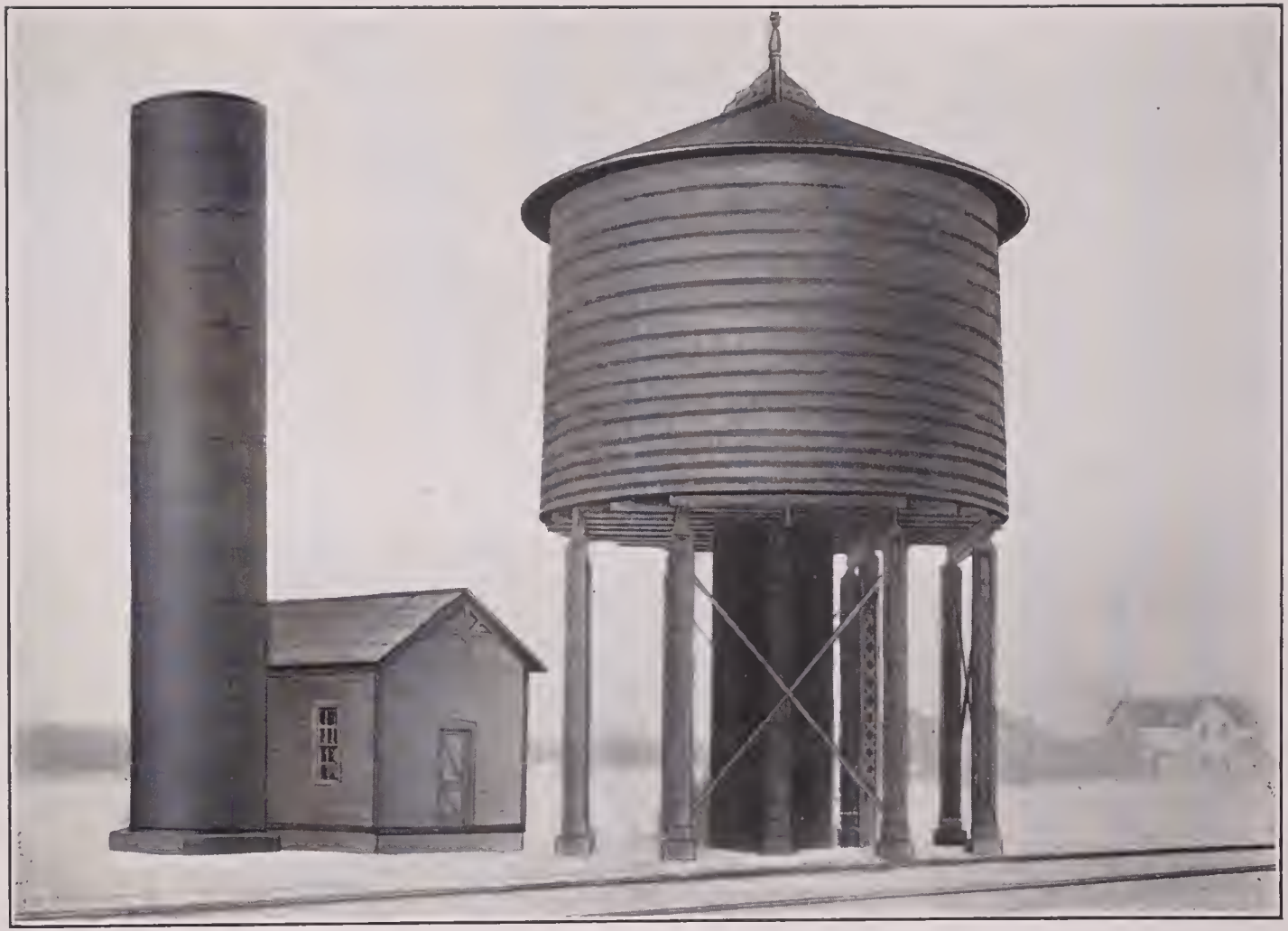
The Pittsburgh Continuous Water Softening Plant

The Pittsburgh System consists of automatically treating varying quantities of water with varying quantities of materials in an automatic apparatus, proportional to the flow of water.

The apparatus is continuous in its action, automatically starting and stopping with the beginning and ceasing of the flow of water into the apparatus.

The water is pumped but once into the machine, and is delivered at the bottom with the machinery always in sight. The water as it flows into the Softener furnishes all the power the apparatus requires for mixing the chemicals properly with the water to be purified, as well as for operating automatically all the mechanicism of the plant.

After the impurities in the water to be treated have been precipitated from the water by the chemical reagents, they are automatically removed from the water as it passes through the apparatus, and the purified water overflows from the top of Softener by gravity into the storage tank, without the necessity of repumping.



THE PITTSBURGH CONTINUOUS WATER SOFTENING PLANT LEHIGH VALLEY RAILROAD CO., BATAVIA, N. Y.

The Pittsburgh System

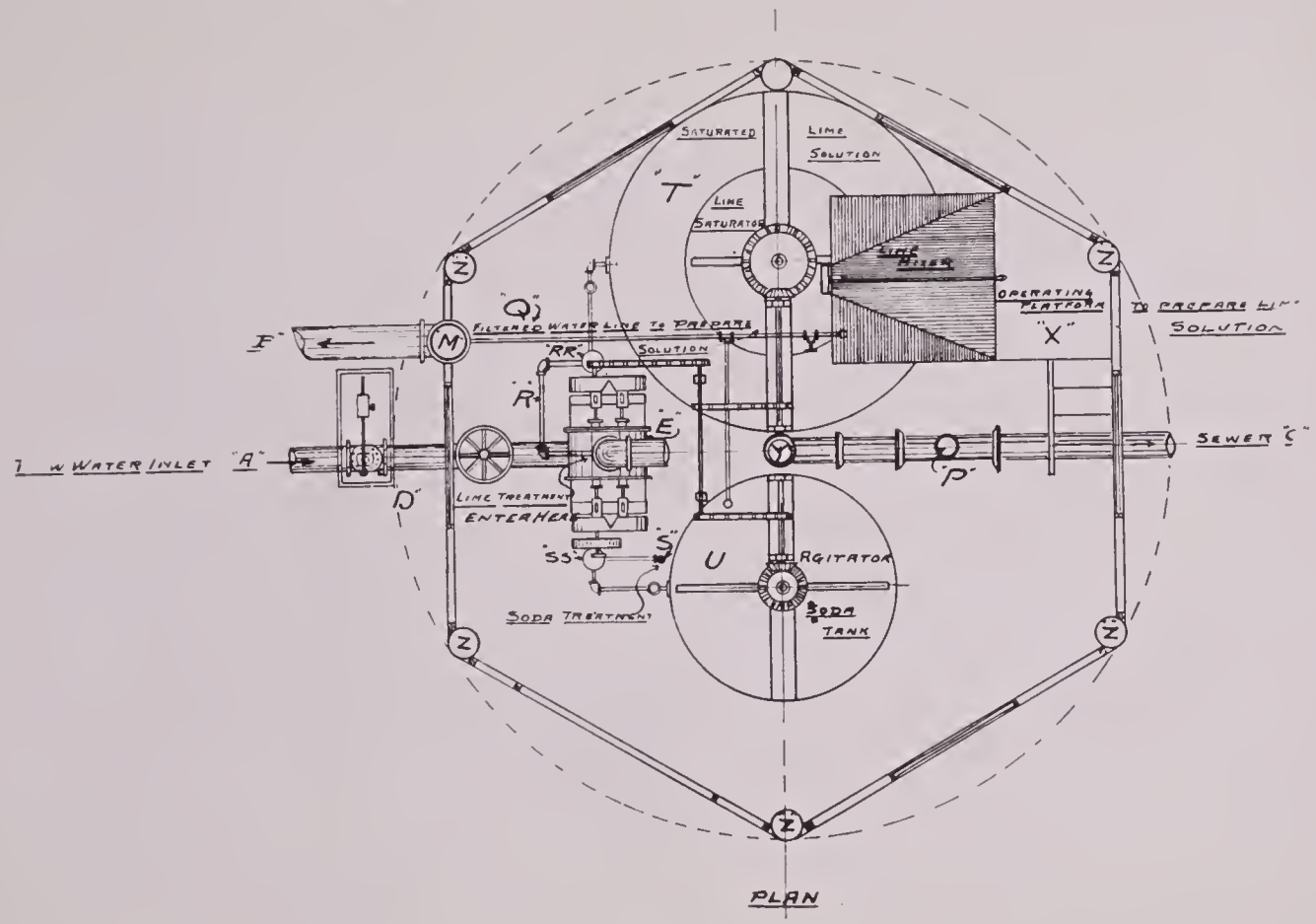
The Pittsburgh Continuous Water Softener requires but a single and simple foundation. The construction throughout is stable, and of the most approved type. The only housing required is at the bottom of the tank, and is very simple and effective; all parts of the apparatus liable to freeze, including the intake pipe and outlet pipe, are inclosed in the main tank, thus protecting them perfectly.

The apparatus is designed to occupy the minimum of space with the maximum of capacity, that the water may have plenty of time in passing through it to have all the objectionable scale-forming solids removed. It requires over four hours for the water to pass through the Softener, and to be subjected to the different processes of purification.

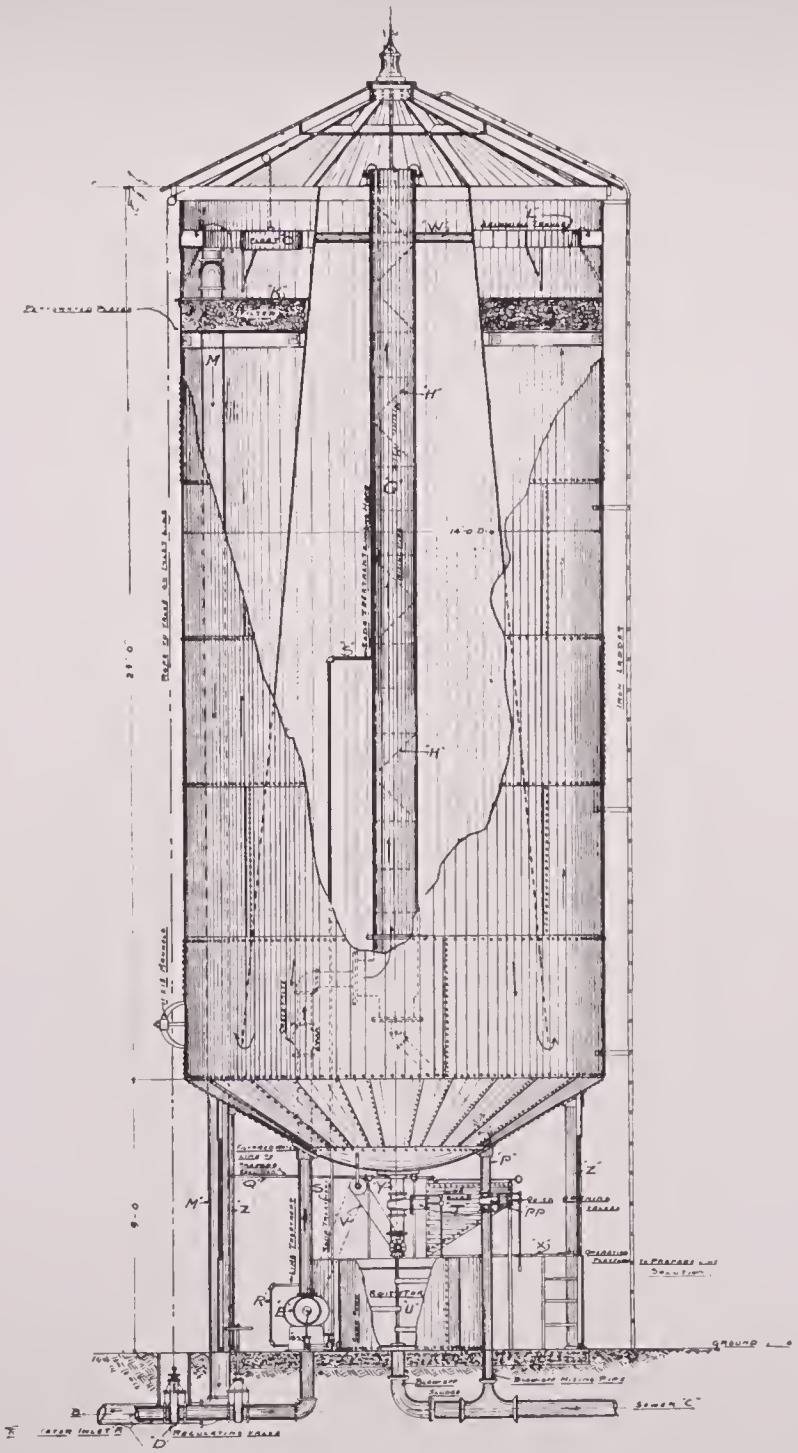
The utmost care and attention have been given to every step in the progress of the water through the Softener, from the thorough agitation and mixture of the chemical reagents with the raw water to the easy removal of the accumulated sludge from the bottom of the apparatus in the form of a thin paste that readily flows when emptied into the sewer.

One man in half an hour each day can give all the attention that is needed for the perfect operation of a Softener with a capacity of 10,000 gallons per hour and this work is performed on the ground level.

THE PITTSBURGH WATER SOFTENING PLANT
THE SIMPLEST CONTINUOUS WATER SOFTENING PLANT IN THE WORLD



PLAN OF THE PITTSBURGH CONTINUOUS WATER SOFTENING PLANT



SECTIONAL ELEVATION OF THE PITTSBURGH CONTINUOUS WATER SOFTENING PLANT

Points

The Pittsburgh System possesses many points of advantage over other methods of softening water:

Its construction is of the most stable character.

It requires but a single foundation and simple housing around its base.

It does not require the repumping of the purified water into a storage tank, but delivers the water direct from the apparatus by gravity.

The entire apparatus is enclosed in a single tank, thus preventing injury from freezing.

It uses purified water for dissolving the reagents.

It automatically varies the amount of materials according to the quantity of water entering the apparatus.

The minimum quantity of reagents are required.

Any one can operate it; it has no secret processes. Everything is simple, plain and understandable. It starts and stops itself whether the operator is present or not.

The pumper is not required to climb slippery ladders in wet and stormy weather to note the operation of the plant or hoist the chemicals for treatment up in the air.

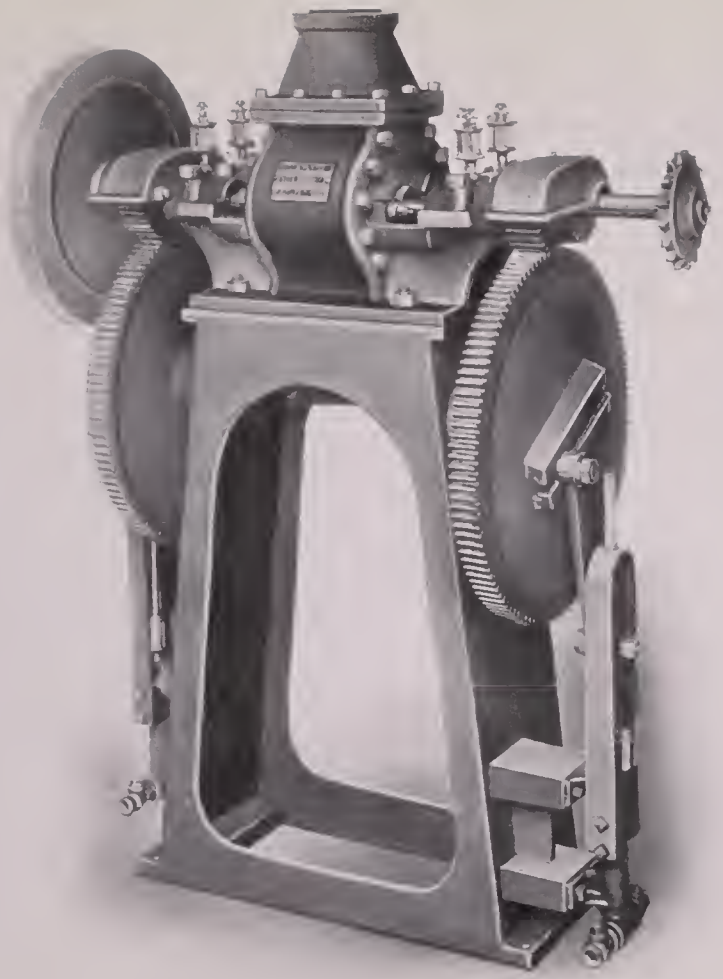
The entire operation of the plant is performed from the ground underneath the Softener where ample room is also provided for 30 days' supply of chemicals.

The chemicals are added to the solution tanks on the ground and are applied to the raw water—just when required and in the proper proportion as if by human skill—not an ounce of material is wasted—enough and just enough is added to produce results.

Tests

A test basin with suitable testing apparatus is a necessity to every installation. The few simple tests used by us exclusively are within the grasp of every pumper or engineer.

If a change in the water supply occurs during the night from a freshet he simply turns a thumb-screw. "The motor does the rest."



PROPORTIONAL WATER MOTOR

For the introduction of a coagulant or precipitant proportional to the flow of raw water—the most perfect device in the world for the purpose.

Constituents and Hardness of Water

1. Clark's Tables of Hardness—1,000 Grains of Water Used

Degree of Hardness	Measurers of Soap Solution	Difference for the Next Degree of Hardness	Degree of Hardness	Measures of Soap Solution	Difference for the Next Degree of Hardness
Distilled water =0	1.4	1.8			
1	3.2	2.2	9	19.4	1.9
2	5.4	2.2	10	21.3	1.8
3	7.6	2.0	11	23.1	1.8
4	9.6	2.0	12	24.9	1.8
5	11.6	2.0	13	26.7	1.8
6	13.6	2.0	14	28.5	1.8
7	15.6	1.9	15	30.3	1.8
8	.5	a	16	32.0	1.7

2. Table of Hardness in Parts per 100,000, 50 c. c. of Water Used

C.C. of Soap Solution	Ca Co_3 per 100,000	C.C. of Soap Solution	Ca CO_3 per 100,000	C.C. of Soap Solution	Ca CO_3 per 100,000	C.C. of Soap Solution	Ca CO_3 per 100,000	C.C. of Soap Solution	Ca CO_3 per 100,000
.7	.00	3.8	4.29	6.9	8.71	10.0	13.31	13.1	18.17
.8	.16	.9	.43	7.0	.86	.1	.46	.2	.33
.9	.32	4.0	.57	.1	9.00	.2	.61	.3	.49
1.0	.48	.1	.71	.2	.14	.3	.76	.4	.65
.1	.63	.2	.86	.3	.29	.4	.91	.5	.81
.2	.79	.3	5.00	.4	.43	.5	14.06	.6	.97
.3	.95	.4	.14	.5	.57	.6	.21	.7	19.13
.4	1.11	.5	.29	.6	.71	.7	.37	.8	.29
.5	.27	.6	.43	.7	.86	.8	.52	.9	.44
.6	.43	.7	.57	.8	10.00	.9	.68	14.0	.60
.7	.56	.8	.71	.9	.15	11.0	.84	.1	.76
.8	.69	.9	.86	8.0	.30	.1	15.00	.2	.92
.9	.82	5.0	6.00	.1	.45	.2	.16	.3	20.08
2.0	.95	.1	.14	.2	.60	.3	.32	.4	.24
.1	2.08	.2	.29	.3	.75	.4	.48	.5	.40
.2	.21	.3	.43	.4	.90	.5	.63	.6	.56
.3	.34	.4	.57	.5	11.05	.6	.79	.7	.71
.4	.47	.5	.71	.6	.20	.7	.95	.8	.87
.5	.60	.6	.86	.7	.35	.8	16.11	.9	22.03
.6	.73	.7	7.00	.8	.50	.9	.27	15.0	.19
.7	.86	.8	.14	.9	.65	12.0	.43	.1	.35
.8	.99	.9	.29	9.0	.80	.1	.59	.2	.51
.9	3.12	6.0	.43	.1	.95	.2	.75	.3	.68
3.0	.25	.1	.57	.2	12.11	.3	.90	.4	.85
.1	.38	.2	.71	.3	.26	.4	17.06	.5	22.02
.2	.51	.3	.86	.4	.41	.5	.22	.6	.18
.3	.64	.4	8.00	.5	.56	.6	.38	.7	.35
.4	.77	.5	.14	.6	.71	.7	.54	.8	.52
.5	.90	.6	.29	.7	.86	.8	.70	.9	.69
.6	4.03	.7	.43	.8	13.01	.9	.86	16.0	.86
.7	.16	.8	.57	.9	.16	13.0	18.02		

Clark was the first to introduce the term "degree of hardness," and in Table No. 1 each measure of soap solution = 10 grains, and each degree of hardness = 1 grain, of carbonate of lime or its equivalent of another calcium salt, or equivalent quantities of magnesium salts in 70,000-parts (= 1 gallon.)